Composite Stringer Pull-off Failure Prediction

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September 2001

Relevant Milestone: Composite Stringer Fatigue Life Model (RAPID #1 due Sep 01)

Shown: Failure mode for delamination of skin and stringer.

Accomplishment / Relation to Milestone and ETO:

The Milestone is complete. The motivation for this work is because future advanced composite fuselages will consist of very thin skins adhesively bonded to reinforcing stringers. If the thin skins are designed to allow buckling motions, then fatigue failure between stringers and skin must be prevented by good design against fatigue failures.

To accomplish the milestone, many analyses of the failure modes were performed using 2D and 3D finite element models. The 3D strain energy release rate results agreed well with the 2D plane stress finite element results, making it possible to use the simpler 2D FEM approach. Mixed-mode delamination percentages were calculated and compared to delamination fatigue characterization data. The steps of analysis were integrated with life characterization data to build the fatigue life model. To validate the final model, fatigue life predictions were then generated and compared to scale model tests. The predictions agreed well with the fatigue life data for scale specimens consisting of skin laminates bonded to laminates simulating the stiffener flange tip.

Future Plans: A Global 2D shell combined with local 3D approach might yield a model to significantly reduce the design cycle time. If this work is to continue, then it will need sponsorship by another NASA or Army project because the Base Rotorcraft Program has ended.

Base Rotorcraft Program

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